GPU NUCLEAR

GPU Nuclear, Inc.
Route 441 South
Post Office Box 480
Middletown, PA 17057-0480
Tel 717-944-7621

1920-99-20605
November 22, 1999

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: Three Mile Island Nuclear Station, Unit I (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
LER 99-008-01, "Reactor Building Emergency Cooling System (RBECS) Outside the Design Basis with Reduced Air Flow Due to Inadequate Consideration of the Potential for Reactor Coolant Leakage to Impact RBECS Performance"

This letter transmits Licensee Event Report (LER) 99-008-01 regarding a degraded but operable condition of the Reactor Building Emergency Cooling System (RBECS). The RBECS was determined to be outside the design basis of the plant and reportable in accordance with 10 CFR 50.72(a)(2)(ii)(B). This supplement confirms the root cause and the adequacy of the corrective actions.

This LER supplement is being submitted pursuant to 10 CFR 50.73(b)(1)(ii)(B), using the required NRC forms (attached). NRC Form 366 contains an abstract that provides a brief description of the evaluated condition. For a complete understanding of the evaluated condition, refer to the text of the report provided on Form 366A.

This condition did not adversely affect the health and safety of the public. For additional information regarding this LER contact Mr. Major R. Knight of TMI Nuclear Safety & Licensing at (717) 948-8554.

Sincerely,

James W. Langenbach
Vice President and Director, TMI

MRK
Attachment

cc: Administrator, Region I
TMI Senior Resident Inspector
TMI-1 Senior Project Manager
File No. 99108

IE22

PDR ADOCK 05000289

NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the Records Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0104), Office of Management and Budget, Washington, DC 20503. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Three Mile Island, Unit 1	05000289	1 OF 9

TITLE (4)

Reactor Building Emergency Cooling System (RBECS) Outside the Design Basis with Reduced Air Flow Due to Inadequate Consideration of the Potential for Reactor Coolant Leakage to Impact RBECS Performance

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
06	04	99	99	-- 008 --	01	11	22	99	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	N
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(I)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(I)	X	50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(I)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Mr. Major R. Knight, TMI Sr. II Licensing Engineer	(717) 948-8554

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On June 4, 1999 during full power operation of TMI-1, GPU Nuclear discovered that the air flow through each of the Reactor Building (RB) fan cooler units was below design basis requirements. TMI-1 has three fan cooler units to cool the RB during normal and emergency conditions. The fan coolers were determined to be operable but degraded due to accumulation of boric acid crystals on the external surfaces of the normal cooling coils of all three (3) units and on the fan blades of the "A" fan cooler unit. This condition was determined to be reportable in accordance with 10CFR50(a)(2)(ii) as a condition outside the design basis of the plant.

The Root Cause of the failure of the RBECS to meet UFSAR design flows was the inadequate consideration of the potential for reactor coolant leakage to adversely impact the RBECS coupled with the lack of permanently installed instrumentation. Public health and safety were unaffected. Calculations completed in September 1999 demonstrate that the air flow which could have been provided at the cooling coils inlet of the most degraded fan unit during a design basis event, prior to cleaning, would have exceeded the minimum requirement. The fan cooler units have been restored by cleaning. Other actions including installation of additional instrumentation and initiation of a long term monitoring program have been completed.

I. Plant Operating Conditions before Event:

TMI-1 was operating at 100% reactor power.

II. Status of Structures, Components, or Systems that were Inoperable at the Start of the Event and that Contributed to the Event:

None.

III. Event Description:

The Reactor Building (RB) Emergency Fan Cooler units (AH-E-1 A, B, and C) (see Figure 1) provide containment energy removal during both normal and emergency conditions. These units [BK/FCU]* are referred to in the TMI-1 Updated Final Safety Analysis Report (UFSAR) as the Reactor Building Emergency Air Recirculation and Cooling Units and in the TMI-1 Technical Specifications (TS) as the RB Emergency Cooling Fans of the RB Emergency Cooling System (RBECS).

Each of the RBECS fan coolers contains normal cooling coils and emergency cooling coils. A single fan draws air from both ends of the unit. The two speed fans operate in fast speed in the normal cooling mode and in slow speed in the emergency cooling mode. During normal operation, the normal cooling coils condition the air inside containment with cooling water provided from an industrial cooling water system while there is no flow through the emergency coils. In the emergency cooling mode, Reactor Building Emergency Cooling Water (RBECW) is pumped from the Susquehanna River through the emergency cooling coils to remove moisture and heat following a design basis Loss of Coolant Accident (LOCA). Air is drawn through the filter/demisters and both sets of cooling coils from a series of ducts located throughout the RB and exhaust directly to the RB lower elevation. Thus a reduced air flow condition during normal operation would likewise affect the RBECS. The fan coolers are located on the north side of the RB at the 289 ft elevation, approximately 8 ft above the RB floor.

The RB emergency cooling function is part of the plant engineered safeguards (ES) system. TMI-1 TS section 3.3.1.3 requires two of the three RBECS fan cooler units operable to assure that the required post accident components are available.

From the beginning of this operating cycle (Cycle 12) until March 1998, TMI-1 had Reactor Coolant System (RCS) leakage below 0.1 gpm. In March 1998 there was an increase in RCS leakage and investigations were initiated to locate the leakage source or sources. From June 1998 until **the event occurred**, RCS leakage **had** remained generally in the range of 0.2 to 0.3 gpm which, well below the TS limit of 1.0 gpm. **The primary RCS leakage contributors were identified during the 13R Outage to be a Reactor Coolant Pump flange leak and Reactor**

Vessel high point vent valves RC-V-42 and 43.

Monitoring of the Reactor Building air temperatures in May, 1999 found the RB air temperatures to be slightly above what was expected for the late spring. Engineering investigation into the cause for the elevated temperatures identified less than optimal RBECS normal RB cooling as a potential cause. Inspection of the RBECS found a high differential pressure across the combined filter and cooling coil banks. Subsequent volume air flow measurements found reduced air flow. The filter/demisters (not required per the UFSAR Appendix 6A) were removed on all three air handling units. However, there was only a small reduction in the differential pressure. High pressure water cleaning of the normal cooling coils of AH-E-1C was performed and there was a small improvement in the pressure differential across the cooling coil banks.

On June 4, 1999, a total system flow measurement of 142,825 cfm for all three fans operating at high-speed indicated that the RB cooling flow per fan was approximately 47,000 cfm assuming an equal flow distribution. An evaluation determined that this flow rate would correspond to approximately 17,000 cfm per fan at slow speed. For conservatism and to account for uncertainties, a flow rate of 15,000 cfm per fan was used in the analyses for a justification for continued **operation**. Because the reduced RBECS air flow was less than that assumed in the plant's analysis **of the environmental profile** for equipment qualification of electrical equipment (EQ), the system was determined to be in a degraded condition. This condition was determined to be outside the design basis of the plant and a one (1) hour report was made to the NRC in accordance with 10 CFR 50.72(b)(1)(ii)(B). However, an evaluation, subsequently documented in an internal Justification for Continued **Operation** (JCO) determined the RBECS was operable but degraded based on engineering judgment. That is, the RBECS was capable of performing its intended safety function as long as the river water temperature remained at or below 85 degrees F and the borated water storage tank temperature was at or below 90 degrees F. Hence, the RBECS was determined to be operable but degraded and reportable to the NRC pursuant to 10 CFR 50.73(a)(2)(ii)(B).

The JCO, entitled "Operation with a Degraded Reactor Building Emergency Cooling System," Report No. 990-2762, Revision 0, dated June 8, 1999, was prepared to document the determination of operability made on June 4, 1999. After cleaning the normal cooling coils on June 6, 1999, additional flow measurements were taken on June 11, 1999. Those measurements found that the slow speed air flow for the AH-E-1B and AH-E-1C fans had been restored to flows greater than the **EQ environmental profile** design basis of 25,000 cfm per fan. The air flow on the AH-E-1A was determined to be approximately 20,000 cfm. The JCO was revised to refine and confirm the analyses and to specify that the administrative limits could be reduced to a single limit on river water temperature of 90 degrees F on the AH-E-1A fan cooler only. The flow rates for the other two fan cooling units were in excess of the 25,000 cfm assumed in the plant's (EQ) design basis.

Additional inspection of the AH-E-1A fan cooler unit indicated flow blockage due to boric acid

deposits that bridge across some of the fan stationary vanes. Observation of the AH-E-1B and C fan cooler units **did** not show a flow blockage.

IV. Component Failure Data:

There were no component failures associated with this event.

V. Identification of Root Cause:

Root Cause

The overall assessment of the work activities conducted during 13R does not alter the previously determined root cause for the event. The buildup of boric acid crystals on the reactor building fan and cooling equipment was confirmed to be the Direct Cause of the reduced flow experienced. As previously stated in LER 99-008-00, the Root Cause of the failure of the RBECS to meet UFSAR design flows was the inadequate consideration of the potential for a known reactor coolant leak to adversely impact the RBECS. Although leakage from the reactor coolant system had been identified since early in cycle 12, the resultant boron fouling of the RBECS was not discovered until RB temperatures became elevated and inspections of the coolers were made: "System interactions not considered." During the 13R Outage, a Reactor Coolant Pump flange leak and Reactor Vessel high point vent valves RC-V-42 and 43 were identified as the primary RCS leakage contributors; repairs were made.

Contributing Cause

Although the reactor coolant leakage has been known for some time, weaknesses in the Equipment Monitoring Program **(coupled with the lack of permanently installed instrumentation)** Contributed by allowing the gradual performance degradation of the RB cooling units to go unrecognized for an extended period: **"Response to a known problem was untimely." Use of the existing instrumentation to periodically monitor the differential pressures could have detected a performance trend before the occurrence of significant degradation.**

VI. Assessment of the Safety Consequences and Implications of the Event:

The function of the RBECS during normal plant operation is to maintain the RB air temperature within the limits of TS 3.17 with the system in the non-emergency mode (fans in fast speed and cooling water flow through the normal cooling coils only). During an accident, the RBECS functions to 1) provide RB heat removal, primarily by condensing the water vapor from the air to assure equipment EQ limits are not exceeded; and, 2) to assist in mixing of the sprayed and unsprayed regions of the RB to mitigate the dose consequences of a Maximum Hypothetical Accident (MHA) event. The RBECS is a system intended for purposes of accident mitigation and does not have the potential to initiate an accident.

During this event, the RB air temperatures were higher than expected for the time of year but below the TS limits. Adherence to the TS limits ensures that the initial RB air temperatures assumed in the accident analyses and equipment aging analyses are not exceeded.

UFSAR Section 6.3.2 stated that the flow rate assumed for the RBECS fans for the **Reactor Building DBE environmental profile** analysis **was** 25,000 cfm. Reduced air flow in the RBECS during postulated accident conditions would result in higher RB temperatures, potentially challenging the **EQ environmental envelope used for** EQ. Lower river water temperature and lower Borated Water Storage Tank (BWST) temperature for initial conditions prior to a design basis accident offset the reduced cooling that would result from lower air flow and therefore assure that the temperature profiles do not exceed those bounded by design basis river water and BWST temperatures.

An evaluation documented in the JCO was performed to determine the ability of the RBECS to meet its intended safety function. RBECS fan cooler air flow measurements with the fans in fast speed (normal RB cooling mode) were used to predict a slow speed single fan flow rate of approximately 17,000 cfm. A conservative assumption of 15,000 cfm flow was used for the JCO analysis. The evaluation addressed RB EQ Profiles, MHA Dose Analyses, Peak Containment Pressure Analysis, and Long Term Core Cooling and Containment Energy Removal. The evaluation concluded that with degraded flow for a single fan of approximately 15,000 cfm, the RBECS would continue to be capable of performing its intended safety function so long as the temperature of the river water remained at or below 85 degrees F and the BWST temperature was at or below 90 degrees F. Administrative limits on river water and BWST temperatures were provided to operators for operability of the RBECS.

The peak containment pressure analysis remains virtually unaffected by the lower airflow as the containment free volume, heat sinks within the containment, and the blow down energy govern the analysis results. Long term cooling is affected directly by the reduced airflow from the RBECS. However, the temperature limitations established offset any reduced energy removal from the RBEC system due to reduced airflow.

Evaluation of the MHA dose consequences with RB fan cooler air flow at 15,000 cfm compared with 29,000 cfm assuming two fan cooler units in operation used the same STARDOSE computer code and assumptions as **were** used to support Technical Specification Change Request (TSCR) No. 274[1]. These results showed that with the conservative assumption of a degraded RB fan cooler air flow at 15,000 cfm, the increase in MHA dose consequences would be minor (10-20%) and remain below the 10 CFR 100 limits.

[1] TSCR No. 274 in part corrected an error in the UFSAR which stated that the RB fan cooler flow rate was 54,000 cfm per fan. **TSCR No. 274 was approved in TMI-1 License Amendment No. 215.**

Additional flow testing under slow speed operation was conducted on June 11, 1999 following cleaning activities on June 6, 1999. These tests demonstrated that air flow for two of the fan cooler units (AH-E-1B and AH-E-1C) in slow speed had been restored to above the EQ design Flow rate of 25,000 cfm. AH-E-1A air flow was improved from 17,000 cfm to approximately 20,000 cfm but remained degraded below UFSAR EQ design basis of 25,000 cfm. The JCO was revised to reflect the improved flows. That evaluation showed that the administrative limit on River water temperature **for AH-E-1A** could be increased from 85 degrees F to 90 degrees F **with no BWST temperature restriction**. Therefore the RBECS **was considered to be capable of performing** its nuclear safety function in accordance with the administrative limits specified for river water temperature as applied to AH-E-1A.

Calculations completed in September 1999 demonstrate that the air flow which could have been provided at the cooling inlet of the most degraded fan unit during a design basis event, prior to cleaning, would have exceeded the minimum requirement under the conditions that existed.

VII. Previous Events of a Similar Nature:

There have been no previous indications at TMI-1 where primary coolant leakage has adversely affected the reactor building ventilation system operation. Deposits of boric acid have been identified in the drip trays for the RB normal cooling coils during the 11R (1995) and 12R (1997) refueling outage inspections in accordance with a maintenance task that requires cleaning and inspection of the normal cooling coil banks each refueling outage. Therefore, based on our previous experience, any buildup of boric acid crystals within the RB fan coolers was not expected to have any adverse impact upon RBECS operation.

There have been prior instances at other nuclear power plants where primary coolant leakage has adversely affected Reactor Building ventilation systems. Davis Besse, Oconee and Farley are some of the plants contacted during this event which had boron buildup on ventilation cooling coils, and each plant provided information on how to best clean the buildup out of the interior of the cooling coil banks. It should be noted that each plant has different coil and duct configurations, and runs different combinations of fans.

VIII. Extent of Condition :

To verify that there were no other factors causing the reduced RB cooler air flow and to determine if any other systems were affected by the boric acid buildup, Engineering and Maintenance personnel conducted extensive walkdowns of the reactor building air handling components and other systems during the 13R outage. Additional systems checked included the AH-C-3A and AH-C-3B cooling coils and AH-E-2A and AH-E-2B fans. The inspection revealed no evidence of any boric acid deposits on the coils or fan

housings. Engineering also verified that the air handling ducts were not obstructed, that the RBECS fan blade pitch was correct, and that ducts and registers were properly sized. No deficiencies were found with any of these components. A check was also made of the RBECS fan cooler gravity dampers to assure they were operating properly. These dampers were found to be operating poorly and were serviced.

IX. Corrective Actions:

A. Corrective Actions Taken:

1. **The normal cooling coils were cleaned on June 6, 1999 to remove boric acid accumulation. Airflow through the cooling coils increased as indicated by system flow measurement, although the airflow through AH-E-1A remained below the (then current) design basis EQ Analysis assumption of 25,000 cfm.**

2. **Administrative limits regarding RB operability with respect to river water temperature and BWST temperature were implemented as interim actions to compensate for a degraded airflow. The limits were adjusted and subsequently lifted upon completion of system cleaning.**

3. **On July 8, 1999, the AH-E-1A fan rotating blades and stationary vanes were cleaned to remove boric acid deposits. Airflow through the cooling coils increased as indicated by system flow measurement.**

4. **RB fan cooler performance was monitored until the end of operating cycle 12 using the existing dP instrumentation and reactor building temperature data.**

5. **During the Cycle 13 Refueling Outage (13R), all RB fan coolers (AH-E-1A, AH-E-1B, and AH-E-1C) were cleaned and inspected. Each unit was then tested and confirmed to produce greater than 29,000 cfm per fan cooler as required by the revised MHA design basis.**

6. **Prior to startup from the 13R Outage, a long term monitoring program was established for the RBECS. The Reactor Building fan cooler units will be monitored during power operation using data gathered from Operations Surveillance Procedures and Preventive Maintenance Repetitive Tasks. Additionally, during each Refueling Outage, the fan cooler units will be tested, inspected, and cleaned as necessary to ensure design basis conditions and assumptions are maintained. All data will be gathered and trended as part of the system monitoring program. When any adverse trend is identified, inspections will be initiated, with corrective maintenance as prescribed.**

7. **Instrumentation was installed during the 13 R Outage to enhance the monitoring capability of the RB air handling system equipment. Installation of local static pressure gauges now allow the pressure differential to be calculated across each of the filter and cooing coil banks in the air handlers and also across the gravity dampers feeding the air handlers. Pressure developed by each of the fans is also available. All of this data will be gathered during monthly Reactor Building entries per Operations Department Surveillance OPS-S98, "Reactor Building Entry Data Requirements, Surveillances and Inspections." These new instruments will aid in recording the data to monitor the cooling coils and filter banks for fouling and determine when cleaning is required (in addition to the Preventive Maintenance refueling outage tasks). The additional data will also help to identify fan performance problems when reviewed along with fan motor current data.**

8. **This LER supplement has confirmed the root cause. All of the corrective actions have been completed. No additional actions were identified.**

* The Energy Industry Identification System (EIIS), System Identification (SI) and Component Function Identification (CFI) Codes are included in brackets, [SI/CFI], where applicable, as required by 10 CFR 50.73 (b)(2)(ii)(F).

Figure 1
Reactor Building Cooler Cross-sectional View